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ABSTRACT

Despite external changes such as those of magnitudes, the functional properties of the visual system also improve with increased age. According to Jean Piaget's centration/decentration theory, the process of perceptual development might continue until adulthood and even after. However, perceptual development should not be understood in all of its aspects as a linear improvement. For example, constancy is better developed in children approximately eight years of age than in either younger or older subjects. Therefore, in such cases, the perceptual development corresponds to a u-shaped curve. The same is true for depth perception, which is best developed in children approximately nine years old. These examples suggest an increased cognitive involvement in perceptual processing that leads to an overemphasized cognitive compensation. The experimental method used in research on perceptual development, however, might influence the determination of the so-called "critical age levels." Nevertheless, perceptual development in children does not correspond either to monotonously increasing nor decreasing improvement alone. Discontinuity seems to be a rule in many aspects of the perceptual development. (Author/FL)

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CONTINUITY AND DISCONTINUITY OF PERCEPTUAL DEVELOPMENT

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The investigation of the continuous course of perceptual development has been neglected. Furthermore, from a methodological point of view, it is quite difficult to distinguish accurately whether observed perceptual development is caused by pure physiological maturation, perceptual learning, or an interaction of the two.

It is often assumed that the functional properties of the visual or other sensory system are intact at birth. However, this assumption is incorrect. For example, with increased age the interocular distance, as well as the size of the eyeball increases continuously. Nevertheless, the number of the receptors, i.e. cones and rods, remains unchanged. The implications of these changes are closely related to stereopsis, distance and size perception, light sensitivity, and quite a large number of other essential mechanisms of visual perception.

The improvement of the perceptual system can be demonstrated from different points of view. For example, BOWER (1971) investigated the coordination of eye movements in infants. He observed that coordination becomes better with increased age. However, perceptual development is not limited to infancy only. MACKWORTH and BRUNER (1970) investigated the visual search strategy of six-year-old children and adults while viewing pictures. They found that the area of the picture considered by children is much smaller than that of the adults. Furthermore, the saccade amplitudes also increased with increased age.

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The increase of the area of a picture considered and that of the saccade's amplitude with increased age is closely related to PIAGET's (1975) centration-decentration theory. PIAGET suggests that a centrated area, i.e. that to which the attention is directed is overestimated in comparison to the decentrated spots. According to this theory, the better correspondance between the physical properties of the visual world and its perception occurs if the observer is able to balance centration-decentration of the environment. The findings of MACKWORTH and BRUNER (1970) suggest, therefore, that adults might perceive the visual world more correctly than children. This interpretation is also supported by the findings of ZINCHENKO et al. (1963) who observed that the exploratory eye movements of three-year-old children is more restricted than that of six-year-old subjects. In general, it can be stated that glancing over a presented picture improves with increased age and the tendency toward attentional centration on details becomes less pronounced.

At this point the question arises how the course of perceptual development occurs.

Let us discuss the example of size constancy. Developmental studies led to controversal results for a general trend with increasing age. PIAGET (1975) found a U-shaped curve. The best constancy for compared sizes to a standard size was produced by seven to eight years old children, then the constancy diminished slowly until the age of twelve, but thereafter increased until adulthood. FISCHER and COHEN (1978) made similar statements. RAPAPORT (1967) found that nine-year-old children give the smallest difference between objective size and its estimation in other distances, but

this difference increased again until the age of fifteen. PIAGET (1975) introduces the idea of the error to the standard. Because more centrations are made for the standard, it is overestimated and the comparison stimuli are underestimated. If this is true, how is it possible that one can observe a change of error with increasing age? According to MACKWORTH and BRUNER (1970), shorter eye movement saccades are observed in younger children. This could explain the incapability to make comparisons between the standard size and the other presented sizes, because they use "steps" which involve a movement from one picture presented to the next, using central vision all the time. Older children, on the other hand, use "leaps" which involve a movement so long that the successive areas looked at are quite distinct. In the first case, the pictures to be compared are more or less separated and isolated, each of them constitues a new event. As sizes to be compared are more distant than the standard, the smaller retinal images lead to an underestimation. In the second case, when different pictures are compared PIAGET's centration-decentration theory provides a basis for understanding the results. These rapid global comparisons make it possible for the short term memory to work more accurately.

Another example is depth perception. Such perception is based on a knowledge of objects in the environment. They provide the criterion for estimation. Children generally do not have such experiental scales. Nevertheless, depth perception is possible in early infancy. But how accurate are these depth perceptions? On the average, error in depth perception diminish until the age of nine and then are found to increase again as was found previously (FISCHER and COHEN, 1978). The improvement with the increasing age in younger children is perhaps more easily explanable; but why does performance detertorate subsequently?

Again, the eye saccades with smaller amplitudes observed in young children may explain why the reference system for depth perception doesn't appear yet, but the transition to larger amplitudes in eye saccades makes comparison of distant objects more and more difficult because decentration needs more comparisons and is consequently much more time consuming. It may lead to an underestimation of the objects in the visual field, while small children overestimate these narrow objects. This means that depth perception in small children shows an underestimation, while in older children and adults one observes an overestimation of distances.

The two examples discussed show the discontinuity of perceptual development. However, the exact age at which the poorest or the best performance occurs may be different from the cited and that a number of experimental conditions (variation of distances, duration of presentation, etc.) must be closely considered. Nevertheless, the discontinuity persists.

In some research of perceptual development, sex differences are manifest. The subject ability to process contradictory information, as in the stroop test improves with increased age. One of the reasons accounting for this improvement may be the alteration in the subjects' shift of attention with regard to the stimuli dimensions. According to our observations in this study, seven-year-old children prefer color as the most important dimension of a stimulus, much more frequently than did twelve-year-old subjects (FISCHER and COHEN, 1978). Furthermore, it can also be assumed that with increased age there is also a general improvement of the processing capacity in relation to a better identification of essential cues entailed in the stimuli.

The finding of a general improvement as a function of the chronological age is perhaps not surprising. However, the improvement observed also depends on the sex of the subject. In general, no differences were observed between the both sexes in the first grade. In the second and the third grade, however, the performance of females was significantly better than that of males. Nevertheless, similar results were obtained on both sexes in the fourth school grade. Subsequently, females exhibited a tendancy toward a better performance than males.

The described sex-specific differences were obtained because of the unequal course of development observed in the sexes. While the females greatly improved from the first to the second grade, subsequent improvement was of only moderate magnitude. On the other hand, the improvement of males between successive age levels never manifested such a great magnitude as that of the females at the beginning. Their improvement remain more constant over the years in comparison to the females.

This example demonstrates the differential development of perception in males and females as cognition becomes more and more complex. Continuity and discontinuity should probably be studied separately for the sexes.

When commenting on perception the development of optical illusions should be considered. PIAGET (1975) also applies his centration-decentration-theory for explaining optical illusions. He distinguishes between three types of illusions.

The primary illusions are those in which the perceived error decreases with increasing age (figure 1). This kind of illusion is presumably caused by field effects. Incomplete couplings give rise to the primary illusions and increased visual search activity subsequently reduces the perceptual error. POLLACK (1970) also suggests that the ontogenetic decrease of perceptual error may depend on physiological maturation, i.e. the reduced sensitivity of the receptors. WEINTRAUB and COOPER (1972) also showed that the perceptual error depends on the contrasts seen.

The secondary illusions are characterized by the direct relationship between the subject's perceptual and cognitive processes. Because the role of the cognitive processes becomes more important with increasing age, the magnitude of the perceptual error also increases until it reaches a certain stable level (figure 2). SPITZ et al. (1970) argued: "Active comparisions give use to greater contrast or illumination among distant elements. Consequently a greater number of couplings increase the perceptual error and secondary illusion presumably increase with increased age".

Finally, a third type of illusion is also characterized by the dependancy between the perceptual error and the subject's age. However, the illusion's magnitude decrease until approximately of nine to eleven years of age. Afterwards, it increases till adulthood (figure 3).

Even though PIAGET and other researchers in perceptual development have provided much data, nonetheless, PIAGET's theory of centration-decentration with many aspects of continuity and many others of descontinuity has never been clearly

demonstrated. The new possibilities of eye movement registration should enable us within the next years to make more definitive statements in this controversial field. Experimental evaluation of these concepts is difficult, but not impossible.

The experimental method used in research on perceptual development, however might influence the determination of the socalled "critical age levels". Nevertheless, perceptual development in children does not correspond either to monotonously increasing nor decreasing improvement alone. Discontinuity seems to be a rule in many aspects of the perceptual development.

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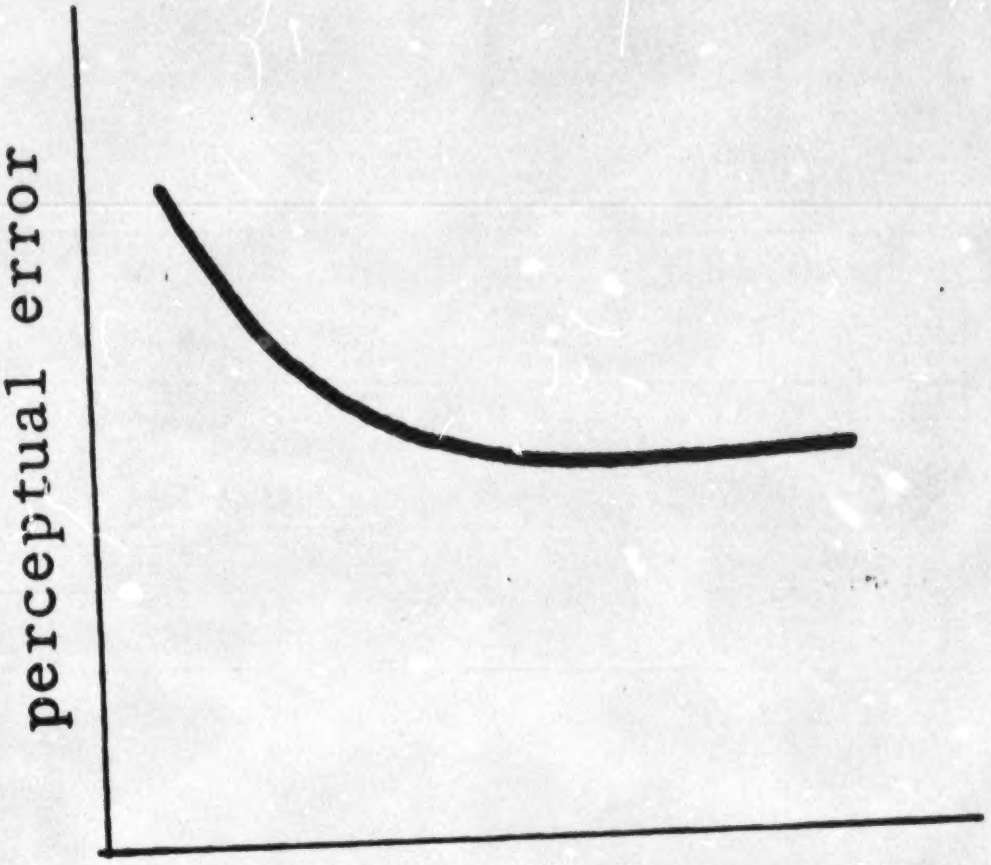
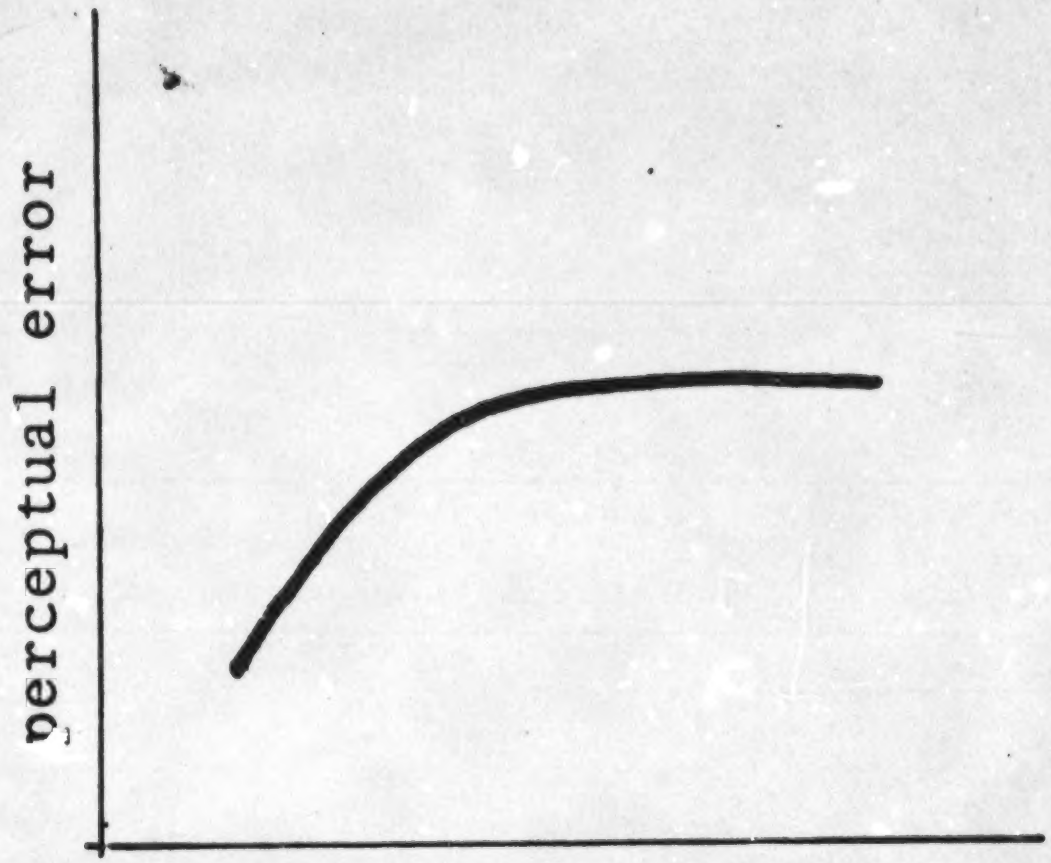
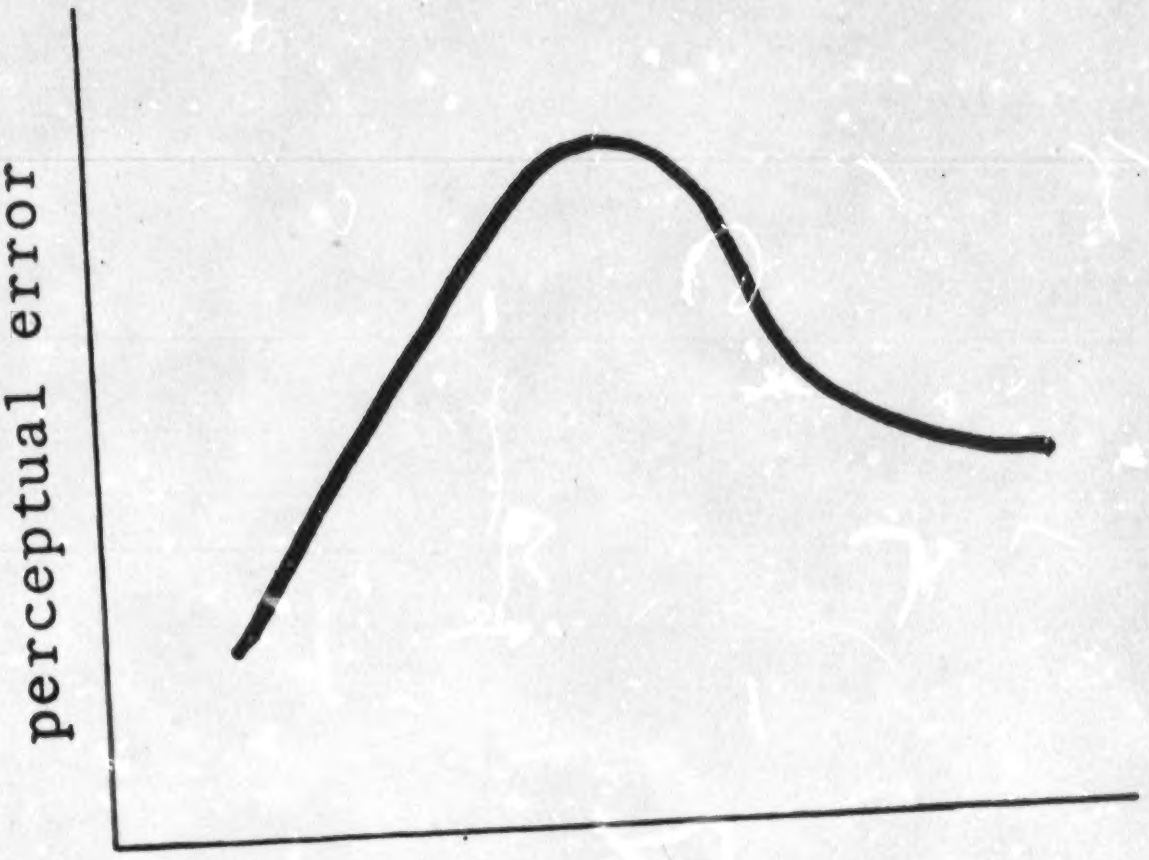


primary illusions



secondary illusions



tertiary illusions